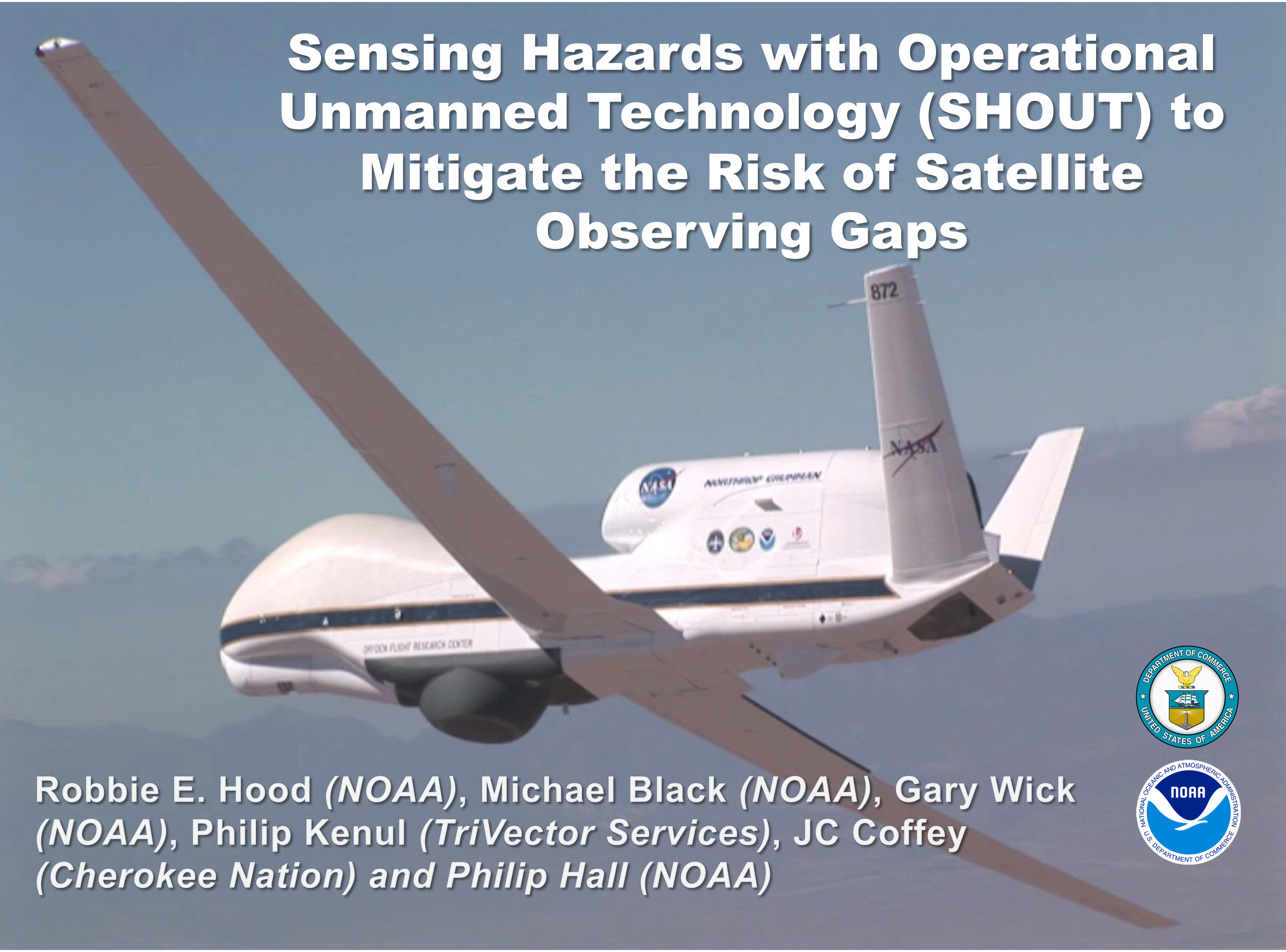
Unmanned Aircraft Systems (UAS) Program

Robbie Hood, Director

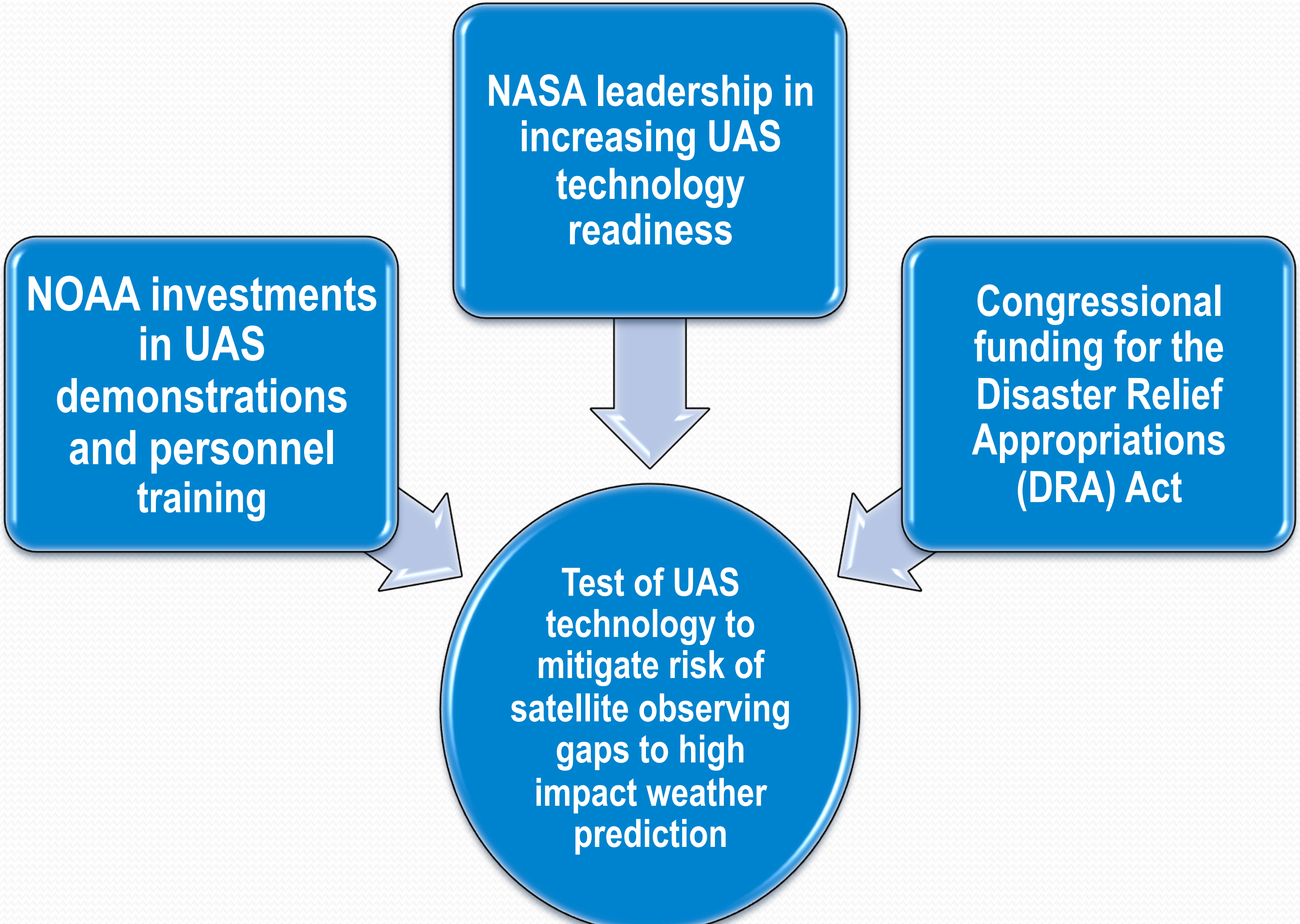
17 April 2014

Sensing Hazards with Operational Unmanned Technology (SHOUT) to Mitigate the Risk of Satellite Observing Gaps



Robbie E. Hood *(NOAA)*, Michael Black *(NOAA)*, Gary Wick *(NOAA)*, Philip Kenul *(TriVector Services)*, JC Coffey *(Cherokee Nation) and Philip Hall (NOAA)*

Synergistic Contributions



Thermodynamic Observations for Tropical Cyclones

Obs	TPIO – Validated Requirements			HAMSR Capabilities (TRL – 7/8)			AVAPS Dropsonde Capabilities (TRL – 7/8)		
	VR	HR	A	VR	HR	A	VR	HR	A
Temp. Profiles	*O* 500m *R* 45 m	*O* 50 km *R* 1 km	*O* 1 K *R* 1 K	1 km	2 km	0.5 K	5 – 15 m	< 1 km	0.5 K
Pressure Profiles	*O* - 9 m *R* 45 m	*O* 10 km *R* 1 km	*O* 1 hPa *R* 1 hPa	N/A	N/A	N/A	5 – 15 m	< 1 km	0.1 hPa
Humidity Profiles	*O* 1 km *R* 90 m	*O* 20 km *R* 4 km	*O* 8% *R* 20%	2 km	2 km	15 – 20%	5 – 15 m	< 1km	5%

Obs – Observations **Temp - Temperature** **VR – Vertical Resolution** **HR – Horizontal Resolution**
A- Accuracy
***O*- Operations** ***R* – Research**

Wind Observations for Tropical Cyclones

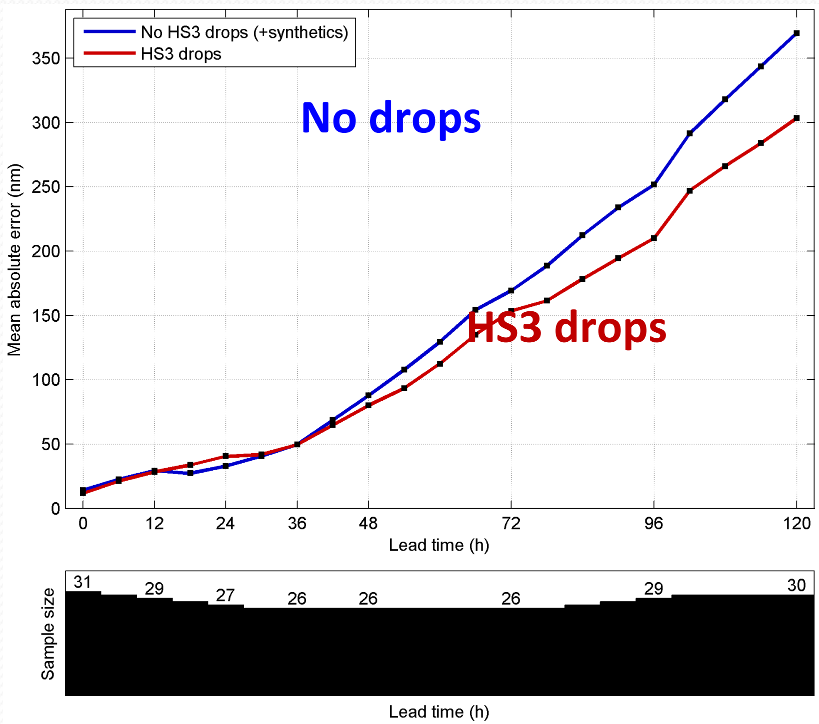
Obs	TPIO – Validated Requirements			HIWRAP Capabilities (TRL – 7/8)			HIRAD Capabilities (TRL – 6/7)			AVAPS Dropsonde Capabilities (TRL – 7/8)		
	VR	HR	A	VR	HR	A	VR	HR	A	VR	HR	A
WS Prof.	*O* 500 m	*O* 50 km	*O* 1 m/s	500m	1 km	0.5 K	N/A	N/A	N/A	5- 15 m	< 1 km	0.5 m/s
	R 100 m	*R* 50 km	*R* 1 m/s									
WD Prof.	*O* 500 m	*O* 10 km	*O* 10 deg	500m	1 km	15 deg	N/A	N/A	N/A	5- 15 m	< 1 km	10 deg
	R 100 m	*R* 1 km	*R 10 deg*									
Sfc. WS	N/A	*O* 1 km	*O* 1m/s	N/A	1 km	2 m/s	N/A	1-2 km	1 - 5 m/s	N/A	< 1 km	0.5 m/s
	N/A	*R* 12 km	R 2 m/s									
Sfc WD	N/A	*O* 2.5km	*O* 10 deg	N/A	2 km	15 deg	N/A	N/A	N/A	N/A	< 1 km	10 deg
	N/A	*R* 12 km	*R* 20 deg									

VR – Vertical Resolution HR – Horizontal Resolution A- Accuracy WS – Wind Speed WD – Wind Direction

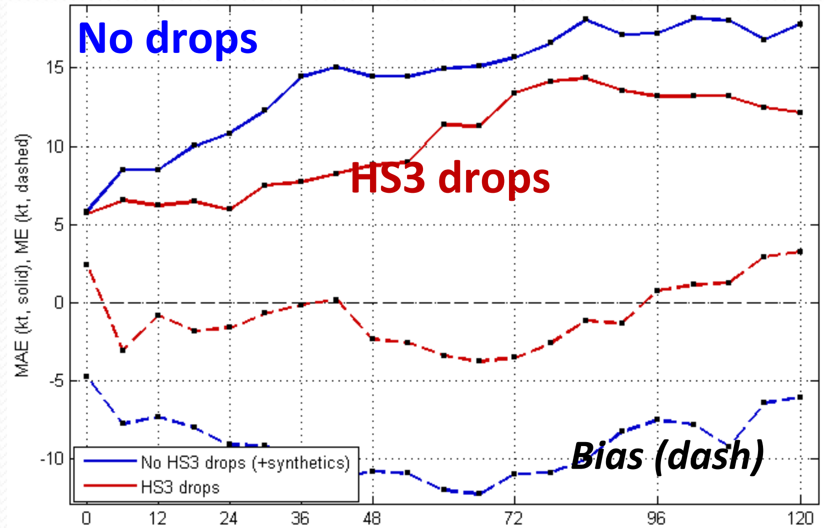
O- Operations *R* – Research

Impact of HS3 Dropsondes for Navy COAMPS-TC Hurricane Nadine Predictions

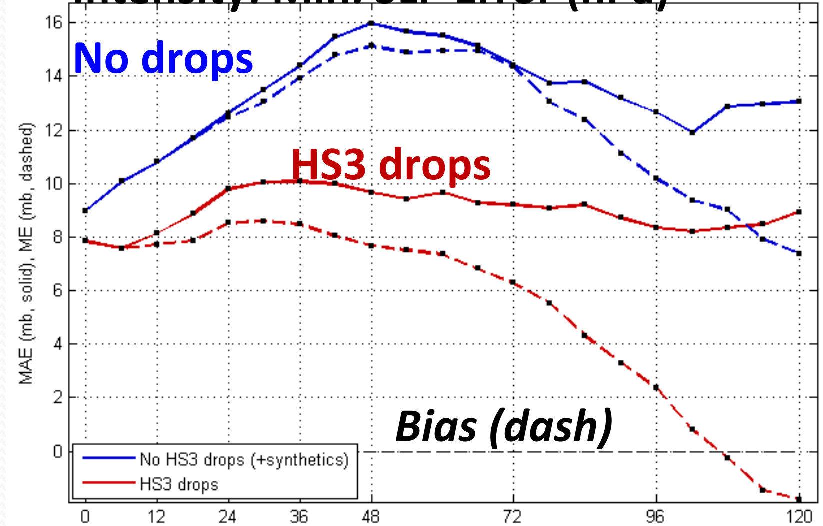
Track Error (nm)



Intensity: Max. Wind Error (kts)



Intensity: Min. SLP Error (hPa)



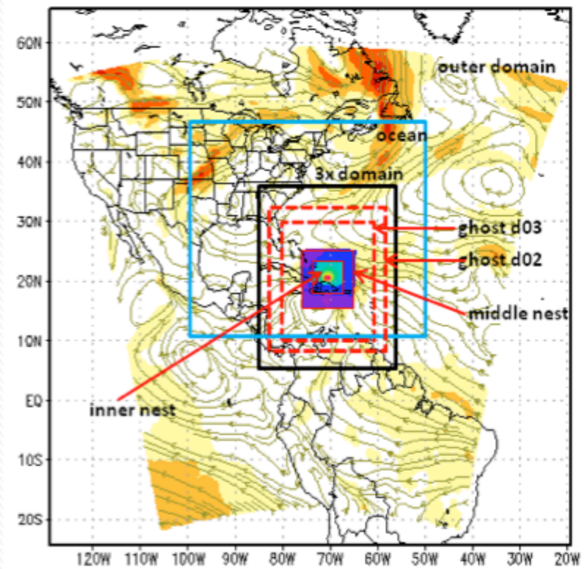
- Dropsonde impact experiments performed for 19-28 Sep. (3 flights)
  - **Red**: with HS3 drops
  - **Blue**: No drops with synthetics
- COAMPS-TC Intensity and Track skill are improved greatly through assimilation of HS3 Drops.

Slide courtesy of James Doyle / NRL

Assimilation of GH dropsondes in HWRF

EXP	Description
HWRF	▪ Operational HWRF 2013
DSA1	▪ HWRF based on operational HWRF 2013 ▪ Raised model top (from 50 hPa to 2 hPa) ▪ Increased vertical levels (from 43 to 61) ▪ GSI based on EMC trunk (October 2013) ▪ 3-hourly FGAT ▪ Variational quality control (VQC) for conventional data ▪ Include more conventional data types and longer data window ▪ Assimilate conventional data only in both parent and inner domains
DSA2	▪ Based on DSA1 ▪ Assimilate GH dropsondes in inner domain
DSB2	▪ Based on DSA1 ▪ Assimilate GH dropsondes with reduced obs error in inner domain

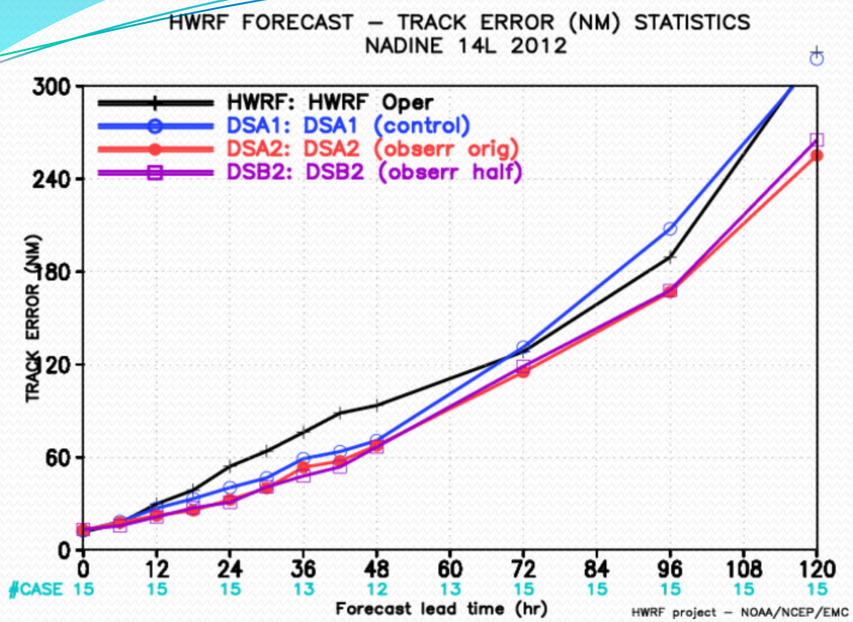
HWRF Domains

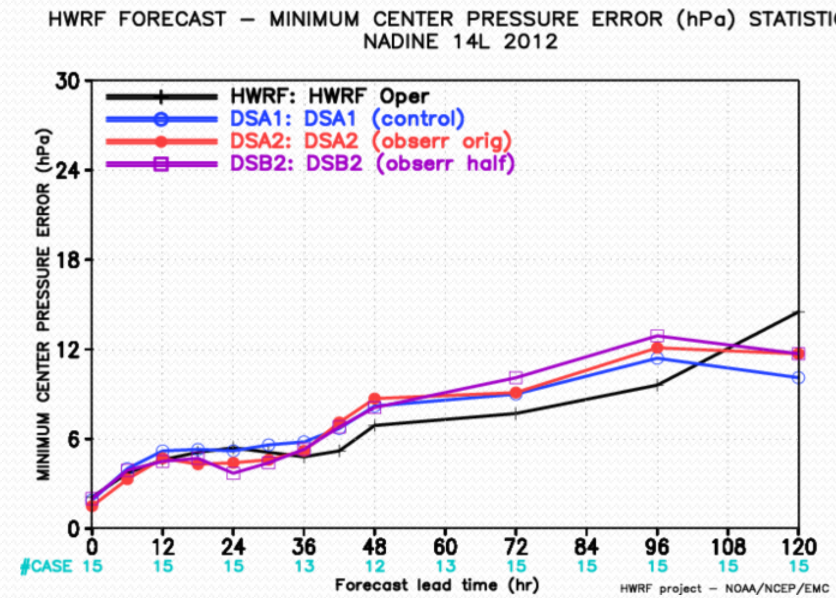


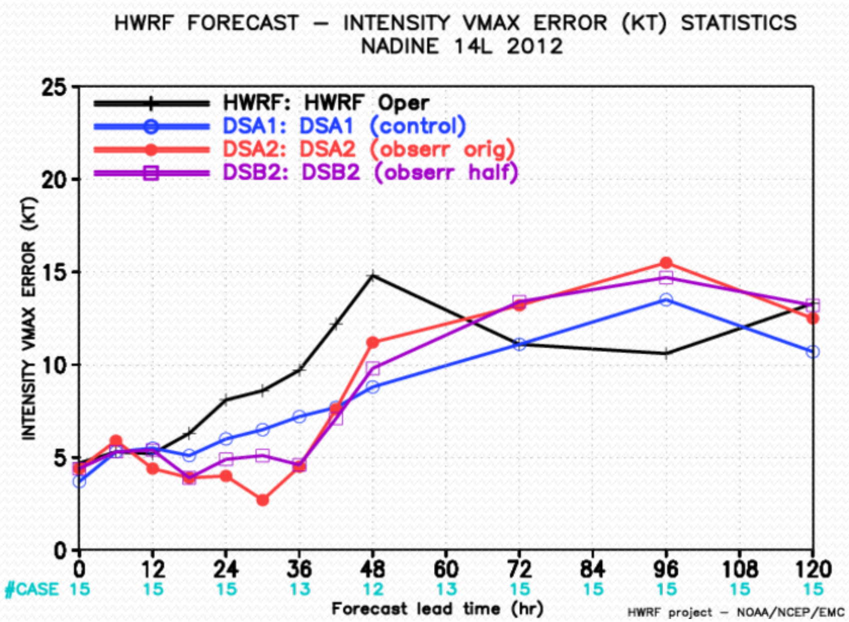
- Observation errors:
  - Temperature, moisture, and wind errors are assigned as a function of vertical pressure
- Potential issues with GH dropsondes assimilation:
  - When available, data has good temporal and spatial coverage in the inner domain; however data is not available for every cycle
  - Dropsondes drift problem; the GPS measured geo-locations at each pressure level are not included in PREPBUFR

Slide courtesy of Vijay Tallapragada / NCEP

Hurricane Nadine 14L 2012





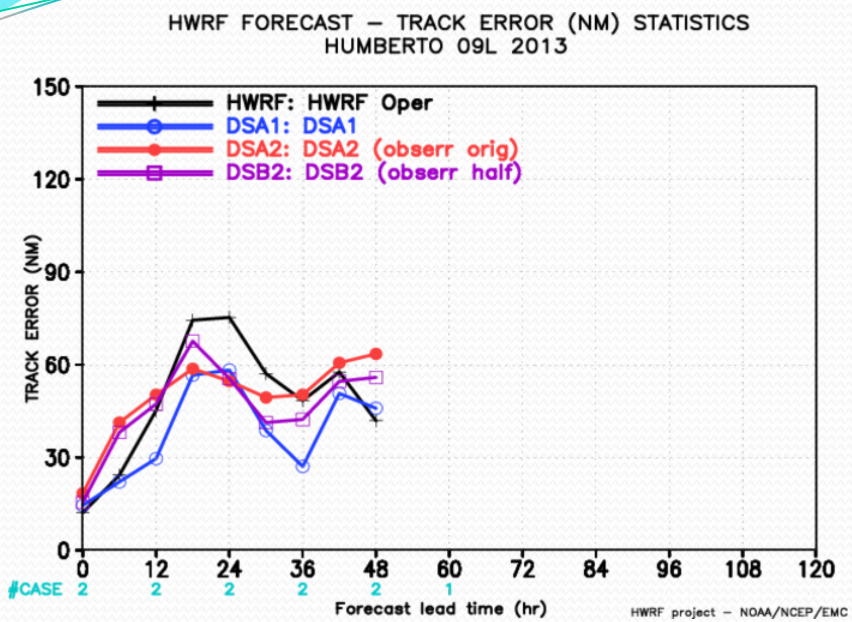


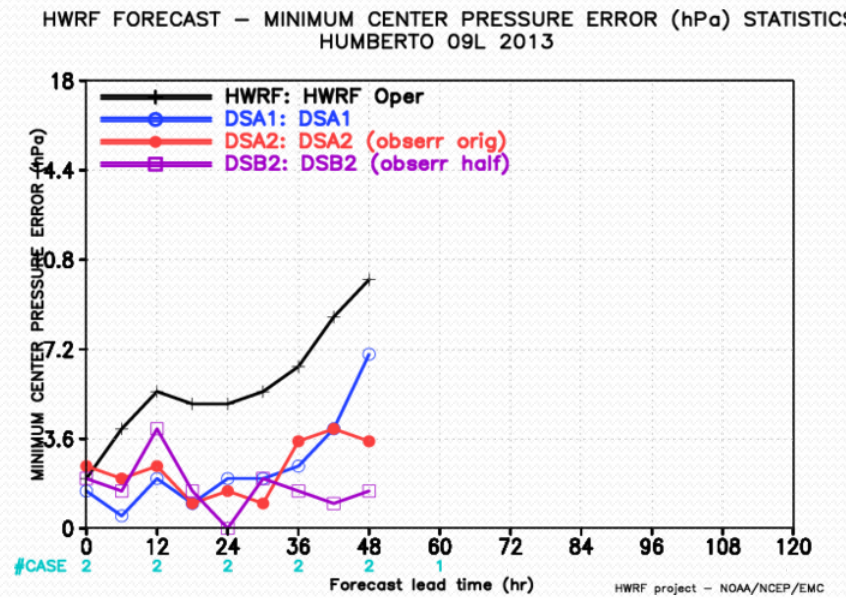
Verification for HWRF forecast from cycles with Global Hawk Dropsondes for H. Nadine (2012):

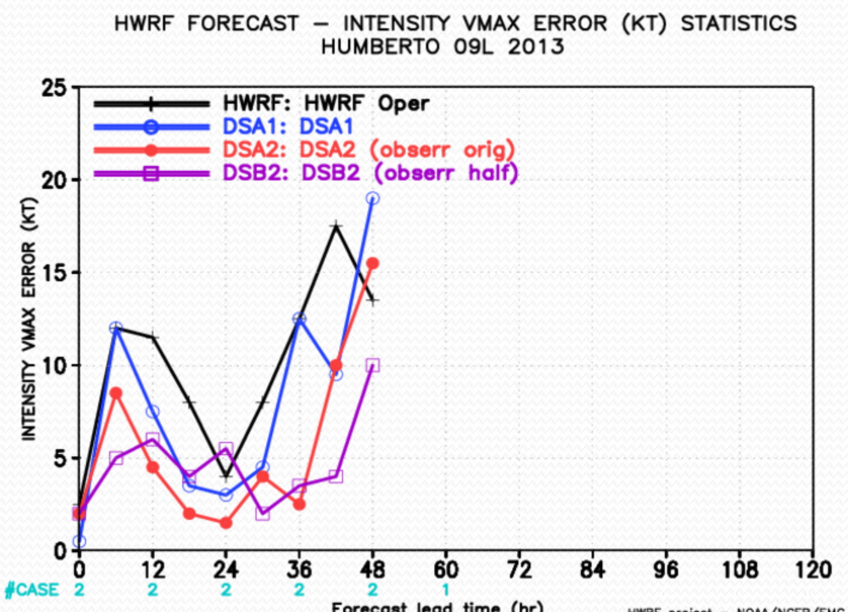
- Significant improvement in track forecasts compared to control
- Intensity (Vmax) errors improved in the first 36 hrs, degraded afterwards.
- No impact on MSLP forecasts

Slide courtesy of Vijay Tallapragada / NCEP

Humberto 09L 2013







Verification for HWRF forecast for two cycles of TS Humberto (2013) with direct assimilation of Global Hawk Dropsondes:

- Neutral impact on track forecasts
- Significant impact on intensity (Vmax) forecasts
- Significant positive impact on MSLP forecasts

Slide courtesy of Vijay Tallapragada / NCEP

Project Objectives

Overall Goal

- Demonstrate and test prototype UAS concept of operations that could be used to mitigate the risk of diminished high impact weather forecasts and warnings in the case of polar-orbiting satellite observing gaps

Objective 1

- Conduct data impact studies
  - Observing System Experiments (OSE) using data from UAS field missions
  - Observing System Simulation Experiments (OSSE) using simulated UAS data

Objective 2

- Evaluate cost and operational benefit through detailed analysis of life-cycle operational costs and constraints

General Plan

FY14

- OSE with previous HS3 data underway
- OSSE with simulated data starting soon for Atlantic / Gulf of Mexico tropical cyclones and Pacific / Arctic weather systems
- 5 extra missions added to HS3
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY15

- Continued OSE and OSSE studies
- 10 – 16 NOAA-dedicated Global Hawk missions
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY16

- NOAA-dedicated Global Hawk missions and possible partnership with NASA Earth Venture experiment
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions
- Finalize data impact studies and analysis of cost and operational benefits

Key Milestones

Major Milestones	Expected Completion
1. Compose science team with OAR, NWS, NESDIS, and OMAO representation	15 February 2014
2. Signed NOAA-NASA Interagency Agreement	1 April 2014
3. Complete initial hurricane UAS impact study	1 July 2014
4. Finish operational prototype UAS mission	1 October 2014
5. Complete real-time data assimilation plan.	1 December 2014
6. Complete initial Pacific/Arctic storm UAS impact study	1 December 2014
7. Deliver preliminary evaluation report, transition strategy and potential acquisition recommendation for FY17 budget planning	1 January 2015
8. Finish operational prototype UAS missions	1 October 2015
9. Complete comprehensive oceanic storm UAS impact study	1 December 2015
10. Deliver updated evaluation report, transition strategy and potential acquisition recommendation for FY18 budget planning	1 January 2016
11. Finish operational prototype UAS missions	1 October 2016
12. Deliver final UAS evaluation report	31 December 2016

Management Team

Principal Investigator

- Robbie Hood, *NOAA UAS Program Director*

Project Scientists

- Michael Black, *NOAA OAR AOML*
- Gary Wick, *NOAA OAR ESRL*

Project Managers

- Philip Kenul, *TriVector Services*
- JC Coffey, *Cherokee Nation Technologies*

OMAO UAS Manager

- Philip Hall, *NOAA OMAO Headquarters*

SHOUT Working Group

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NOAA Office of Marine and Aviation Operations (OMAO)	• Philip Hall
NOAA National Environmental Satellite, Data, and Information Service (NESDIS)	• Mitch Goldberg • Steven Goodman
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